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A STREPTOBACILLUS FROM URINE *

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In the routine bacteriologic examination of specimens of catheterized urine we have repeatedly isolated an organism which we were unable to identify with any of the bacteria described in the literature available. As it occurs in the urine, the organism bears a striking morphologic resemblance to a long chain of streptococcus. In early subcultures on solid media it is coccoid, but later becomes definitely bacillary in form. In fluid media there is constant chain formation. We believe therefore that this organism should be included among the streptobacilli.

Attention is called to this streptobacillus on account of the readiness with which it may be confused with the streptococcus. At first regarded as a contamination, it was not until its association with bladder symptoms was noted, that a more extensive study of its cultural and biologic characteristics was undertaken.

MORPHOLOGY AND CULTURAL CHARACTERISTICS

Only those characteristics are recorded that are essential to the identification of the organism.

It is a gram-positive, pleomorphic bacillus.

In recent cultures the individuals are mostly coccoid, with sharp pointed ends, occurring frequently in pairs resembling pneumococci. In older cultures the predominant form is a short, rather plump bacillus. In broth cultures the organism occurs in long and short chains, or as diplococci. No capsule demonstrable.

On agar there is a moist, gray growth, confined to streak, sometimes sticky in consistency.

On glucose (2%) ascitic fluid agar growth the same as on agar; marked precipitation¹ in twenty-four hours.

On glucose (2%) broth a diffuse clouding, heavy, granular sediment.

* Received for publication May 19, 1917. This study was carried on under the tenure of a Moses Heineman Fellowship.

¹ Libman: Jour. Med. Research, 1901, 1, p. 84; Bull. Johns Hopkins Hospital, 1906, 17, p. 215.

On human blood agar a gray, moist growth, no hemolysis.

Inulin is not acidified.

Litmus milk is acidified and coagulated in four days.

Gelatin is not fluidified.

Bile does not dissolve the organism.

Potato, a heavy white, moist growth.

Acid is produced in dextrose, sucrose, lactose; none in mannite; no gas.

This communication is based on the study of 3 strains isolated from the following cases:

Organism A was recovered from a case of chronic prostatitis with dysuria and frequent micturition. The organism has been recovered at intervals over a period of 6 months, always in association with *B. pyocaneus*. Slight improvement under local treatment and autogenous vaccines.

Organism 332 was recovered from a case of mixed tumor of the right kidney with dysuria, hematuria, and pain on the right side of abdomen. Right nephrectomy; recovery.

Organism 464 was recovered from a case of chronic prostatitis and edema bulbosum vesicalis with dysuria, dribbling of urine, and pain in the region of the bladder. Symptoms were relieved by daily irrigations with nitrate of silver.

It appears to us that this streptobacillus has a special predilection for invading the urinary tract and maintaining itself there. We have no information as to its portal of entry or as to whether it reaches the bladder by an hematogenous, an ascending or a descending route.

To determine the pathogenicity of the organism for animals, several mice and guinea-pigs were injected intrapéritoneally and subcutaneously with a 24-hour culture of Organism A. One mouse died 11 days after an intraperitoneal injection. The findings were negative and *B. proteus* alone was recovered from the peritoneal cavity. The other animals remained well. A rabbit was injected intravenously with the same culture. It remained well for 5 days and was then re-injected intravenously. The animal showed no signs of illness and was killed 6 days after the second injection. Cultures from the heart blood remained sterile but from the urine the injected organism was recovered in pure culture. We then made a series of experiments to test whether the organism would consistently show predilection for the urinary tract of rabbits.

A series of preliminary experiments was made to determine the sterility of rabbit urine as well as the best method of securing specimens of urine from the same rabbit at repeated intervals.

It was first attempted to express the urine from the rabbit's bladder directly into a sterile vessel. This did not prove satisfactory, however, as a number of contaminating bacteria were usually found, including cocci, which proved difficult to differentiate from the streptobacillus.

Under anesthesia, the hair was removed from the lower abdomen with a solution of sodium sulphid, and the skin was sterilized with tincture of iodine. Under aseptic precautions, an incision, about 1 cm. long, was made above the symphysis, the bladder grasped with anatomic forceps and delivered. The bladder was then punctured with a fine needle and the urine aspirated. The wound was closed with silk sutures. The procedure takes from 3 to 5 minutes. Healing was practically always by primary union, and in the few cases where slight infection of the skin wound occurred the animal was not again aspirated until the infection had entirely disappeared.

The bladders of 6 rabbits subsequently used in our experiments were aspirated in this manner, and the urine obtained from all was sterile.

In view of the uniformity of these results it seemed unnecessary to make preliminary cultures in the remaining animals of the series.

The series of experiments is summarized as follows:

SUMMARY OF EXPERIMENTS

Organism	No. of Animals	No. of Urine Cultures Positive	No. of Ureter Cultures Positive
A	12	11	2
332	4	4	
464	4	2	1

It is evident that the streptobacillus, even in enormous intravenous doses, is not lethal for rabbits. Blood cultures taken from the ear vein show that the organism may remain in the circulating blood for 24 hours after intravenous injection. This observation was made repeatedly. In only one instance was the blood culture positive after 48 hours, then becoming negative.

The organism has been recovered from the urine in the bladder as early as 24 hours after the intravenous inoculation and quite regularly after 48 to 72 hours. It has been recovered from the urine by aspirations of the bladder at intervals over as long a period as 49 days.

In 3 animals, whose urine contained the streptobacillus, a cannula was inserted into the ureter about 1 cm. below the pelvis of the kidney, and the organism recovered in large numbers in pure culture from the urine thus collected.

Cultures were made from the emulsified kidneys of two of these animals and no streptobacilli were recovered. The cultures from the kidneys of another animal whose ureters were not catheterized were positive. It is possible that the result in this animal was due to inclusion in the emulsified tissue of a portion of the pelvis containing streptobacilli.

The kidneys from 6 of the rabbits were carefully examined. None showed any gross or microscopic lesions which could be attributed to the organism in question, although several showed the so-called idiopathic or spontaneous nephritis commonly found in rabbits.

Those kidneys which were obtained a considerable time after injection of the streptobacillus showed no bacteria in sections stained with the Gram-Weigert method. These sections were prepared from alcohol-fixed material by the paraffin method, and the stain used was filtered through a Berkefeld filter. Two kidneys, however, removed from animals only a few days after the injection showed typical chains of the organism lying on the pelvic mucous membrane, while in one kidney a small number of organisms in clumps were seen in the loops of a few of the glomerular tufts.

The aspirated urine from several animals contained a trace of albumin and epithelial cells which are frequently normal constituents of rabbit urine.

It seems reasonable to suppose that the streptobacillus passes from the blood through the kidneys into the urine. We have not discovered just how this occurs. We believe that the weight of evidence indicates 1, that the kidney does not normally filter bacteria from the blood into the urine; and 2, that bacteria only pass from the blood through the kidney into the urine when some lesion is present, even though this may not be discoverable with the microscope.

Nephritis is so common in adult rabbits that practically none are absolutely free from it. It is probable that the organism gained passage to the urine through these abnormal areas. On the other hand, in another series of experiments on rabbits, we have injected intravenously large doses of an hemolytic streptococci recovered from gastric ulcers. When these animals were sacrificed cultures were taken from the heart blood, bile, and urine. In a few animals the blood contained

streptococci, but in only one of these were streptococci found in the urine. The urine from the other animals was sterile. Similarly one of us has injected *Staphylococcus aureus* into the renal artery of dogs and collected the urine for 2 hours from both ureters. The staphylococci were not found in the urine from either the injected or uninjected side although both the general and splanchnic circulation were teeming with these organisms.

It would seem, therefore, that this streptobacillus possesses some peculiar biologic property which enables it to live in the urine and maintain itself in the bladder and probably on the mucous membrane of the ureter and renal pelvis also.

CONCLUSIONS

A hitherto undescribed, gram-positive streptobacillus has been isolated repeatedly from the urine of cases suffering from bladder symptoms.

It is of low virulence and large doses injected intravenously into rabbits do not kill the animals. The organism does not usually remain in the circulating blood longer than 24 hours.

After intravenous injection the streptobacillus can be recovered from the bladder urine sometimes as early as 24 hours, and regularly after 48 to 72 hours.

It has also been recovered from the urine secured by ureteral catheterization several days after intravenous injection, but has not been recovered with the same regularity from the kidneys of these animals.

This organism seems, therefore, to possess peculiar biologic properties which enable it to maintain itself in the urinary bladder, and probably in the ureter and renal pelvis as well, for an indefinite period.